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Potential of Post-Industrial Waste Landscape in Addressing Floods in Coastal Urban Slums

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Abstract

Urban landscape and public space are most vulnerable to climate hazard while at the same time plays as a significant green infrastructure towards addressing climate risk and building flood resilience. The challenge put forward by the climate change, putting infrastructure to its limits, is forcing to welcome the potential of waste landscape as essential adaptation element. The objective of the paper is to showcase the case examples from developing countries like Jakarta, Bangkok, Bangladesh and India, conceiving the significance of waste landscape in creating the water strategy for flood resilience pertinent to urban slums. The analysis focused in showcasing the physical capabilities of landscape as flood risk management infrastructure and creating a framework of elements and measures derived from cases and presented in parameters of resist, delay, store and discharge. Results illustrates a new visual alphabet that displays a toolkit of measures and a lexicon of ideas for coastal urban slums. Thus the potential of waste landscape in the implementation of effective adaptation action towards urban slum flooding is identified and systematized.
Keywords- Adaptation, Flood Resilience in Slums, Slumscape, Waste Landscape

I. INTRODUCTION

In the light of experienced hazards, urban slums are among the most vulnerable areas as to the impacts of climate extremes. Slums along the coast and river basins are particularly vulnerable, as they occupy the low lying marshy mangrove swamps and have limited capacity to prevent and absorb the effects of natural disasters. According to the IPCC, there is high confidence that "coastal systems and low-lying areas will increasingly experience submergence, flooding and erosion throughout the 21st century and beyond, due to sea-level rise" [1]. "Flooding in urban areas is not just related to heavy rainfall and extreme climatic events, it is also related to changes in the built-up areas themselves. Urbanization aggravates flooding by restricting where floods water can go, by covering large parts of the ground with roofs, roads and pavements, by obstructing sections of natural channels, and by building drains that ensure that water moves to rivers more rapidly than it did under natural conditions. Such situations frequently arise where poor people build their shelters on low-lying flood plains, over swamps or above the tidewater on the coast" [2]. The lack of green and open surfaces in the city results not only in a lower quality of life for citizens, but also in a low surface infiltration capacity. Urban landscape and public space when combined with local community mobilization open new possibilities for addressing future floods and in gaining resilience in urban slums. Waste post-industrial landscapes act as major infrastructural elements to provide for storage and discharge of water, being essential comprehensive water management strategy. The advantage of landscape is that it counter-balance the exploding urbanization. "Living with nature' has become a common requisite in developed countries, which has propelled a new relationship between humankind and its surrounding environment, one that is no longer obsessed by its control but is rather focused on living in harmony with it" [3].

Although not as a focal issue, flood adaptation measures applied in the urban landscape and public spaces have been discussed by authors and researchers. Analyzing the existing knowledge in a systematic way with the focus on urban slums is important, for shaping the climate resilient future slumscape.

II. LITERATURE REVIEW

"Resilient design adopts lessons from nature to protect, restore, and enhance the ecosystem services of the natural environment in mitigating the impacts of flooding, extreme weather and climate change" [4].

Developing countries from global south host the majority percentage of urban slums. The case examples from developing countries like Jakarta, Bangladesh, Bangkok and India provides for coping strategies and measures of adaptation. Efforts include and showcase the potential of public space to address worsening floods. Adaptation measures applied being categorized as 1) harvest such as green roofs, green walls, blue roofs or collective gardens etc. 2) store such as bio-retention basins, underground reservoirs, step-wells or 3) infiltrate such as permeable paving, infiltration trenches.

Bangkok was built on flat agricultural land that could absorb water naturally, but with urbanization and concreting over canals now causes regular flooding. Landscape architect Kotchakorn Voraakhom, winner of 2020 UN Global climate action awards, build innovative landscape solutions for urban resilience. The project of Centenary Park at Chulalongkorn University located in the center of the city is an example. Below this 11 acre park lies the underground water reservoir that can hold million gallons of water. “Under normal conditions, water that is not absorbed by plants flows into these receptacles, where it is stored for watering during dry periods. When severe floods hit, the containers hold water and release it into the public sewage system after flooding has subsided” [5]. The same process and application can also be envisioned in existing waste landscape elements from the history.

“In the past, we used to live with water, but nowdays you can’t live with water because (of) the way we developed our city based on cars, based on roads, rather than using the canals. (Canals) are very key to the natural infrastructure, but we destroyed it … and how could the water drain?” [5].

Fig. 1: Centenary Park at Chulalongkom University, Bangkok (https://unfccc.int/climate-action/momentum-for-change/women-for-results/nature-based-solutions#eq-1)

Fig. 2: Centenary park at Chulalongkom university, Bangkok (https://www.cnbc.com/green-cities-rewilding-techniques-in-urban-areas/).

According to World Economic Forum, Jakarta is the world's fastest disappearing city with no underground water and city sinking with floods even without rains. It is noted, according to the report by Geoff Thompson, Jakarta is slipping below sea levels at 6cm/year making the city unlivable. Jakarta is facing 6mm/year sea water rise and recently in January 2020 experienced heaviest rainfall in last 24 years. The sinking of Jakarta is mainly attributed to urban development and solid-waste disposal in water channels. The slums in Jakarta, beside along the railways, mostly are found along the river and narrow ducts that typically run through slums around the Ciliwung river’s edge. The potential of Dutch waterways created in 1920 in Jakarta which showcases an essential landscape and tool of adaptation to address the floods in Jakarta. The upgrading initiatives for slums, primarily focuses on development and structuring the public spaces like streets and squares to improve the capability to absorb and provide flood resilience.

In India, more than ever, floods are washing the urban slums in Mumbai. The drainage system was constructed to handle rainfall at the rate of 25mm/hour. The city is actually subjected to approximately 100mm/hour which already stretches the existing capacity [6]. Building over the natural water flows combined with other factor like lack of waste management, clogged drains produce a catastrophic scenario. As noted in the recent policy research working paper of Archana Patankar, "42 percent households have reported that flood waters enter their house every year during monsoon. The average depth of flooding inside the house is 1.3 feet and the house remains flooded for average 2 hours" [7]. Resulting in local community driven measures an essential tool of adaptation. Slum dwellers prepare in accordance to the past instances and adapt to the risk of flooding. This includes raising of plinth and preparing retention walls with sand bags, using plastic sheets to cover the windows and roofs, cleaning the drains to let the monsoon water flow easily etc.

In Mumbai, the public space of water tank – step-wells and maidans – open grounds are rooted from past in the contemporary urban fabric of the city. "The water tank is a public space, water source and place of ceremony; it is ritual space. It is a social gathering place, especially for women, and holds a central place in daily domestic routines as much as it does in religious and cultural celebrations. The tank is a shared resource, shared space and relic of the past" [8]. The monumental step-wells were built separate from settlement areas as stepped ponds and tanks to meet the water demands.

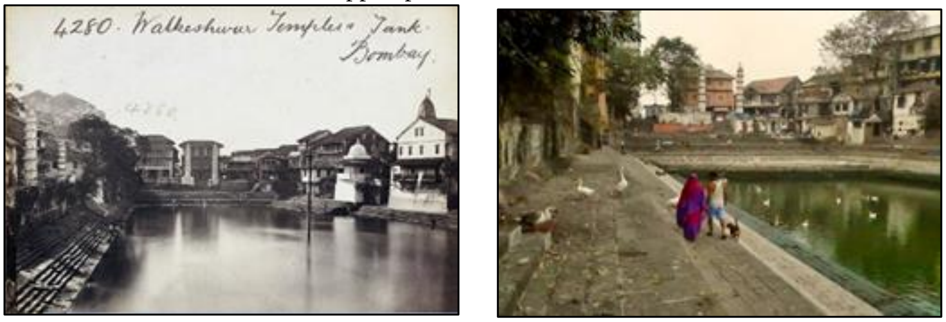

Fig. 3: Water tank – step-well: Banganga tank in Mumbai, before - after (Image 1. http://mumbaimag.com/from-bombay-to-mumbai-a-journey-through-postcards-part-3/) (Image 2. http://bijoor.me/2015/04/03/cycling-to-banganga-tank-and-walkeshwar-temple/)

In present scenario, the tanks, prone to low water levels and high levels of pollution, are seen as unnecessary and hazardous. Most of the tanks are filled and buried beneath buildings, roads and maidans. The island city Mumbai (Mumbai District) has water tanks 1. Manmala Tank 2. Gopi Tank 3. Khara Tank 4. Nadulla Tank 5. Naigaum Tank 6. Elephinstone Tank 7. Parel Tank 8. Gowalia Tank 9. Babula Tank 10. Mumbavedi tank 11. Banganga Tank 12. Framjee Cowasjee Tank 13. Nawab Tank and 14. Cawasjee Patel Tank. These tanks has significant manifestation as traditional structuring element and in representation of living heritage and elaboration of culture. The same provide for valuable landscape element to store and discharge water during flooding. “As the city continues to destroy old fabric and produce new pieces of the city at an astounding rate, it is crucial to understand, reuse and rein-vent dominant traditional forms in an effort to strengthen identity and provide stability in an era when much of the past is replaced by homogeneous and generic buildings and blocks. The high levels of association and interdependence between spatial elements, functions and social behavior of residents, and the ability of the tissue to adapt and evolve over time, suggest that the tank and its urbanity may have a role to play in contemporary urbanism" [8]. Mumbai hosts a great number of extensive open spaces – including a specifically Indian typology called maidans, vast green fields. Maidans are an exceptional urban phenomenon that can be retrofitted to address the flooding in future. Even inside Dharavi, Mumbai's largest informal settlement and Asia's largest slum, there exists a maidan. "Just as the lotus, that great Hindu flower, springs from the dirtiest and most inhospitable of surroundings, so does Indian cricket arise, grow and blossom on these maidans, dotted all over the urban landscape" [9].

Fig. 4: Open field – maidan at Dharavi slum, Mumbai (http://maciejdakowicz.com/cities/mumbai-india-street-photography/).

Fig. 5: Dhobi Ghat in Dharavi slum, Mumbai (https://www.reisenergie.nl/dhobi-ghat-mumbai/).

Another example of flood prone mega-city is Dhaka, the capital of Bangladesh. Dhaka is situated in the delta of rivers and is subjected to flooding. Floods being a common feature in slums. "About half of the respondents stated that the flood that hit them worst reached a level of more than 2.5 feet in their living room, that their dwelling remained under water for more than 15 days, and that the flood had covered the areas in front of and surrounding their home for more than 30 days" [10]. Many households are forced to take shelter in public grounds or on elevated streets or embankments, public space being rendered as a place of safety and resilience. "Under normal flood conditions simple strategies like blocking the entry of the house with sandbags, positioning one's personal belongings on stilts of bricks or hanging them under the roof are sufficient to prevent any severe flood damage" [10]. In the case of extreme floods, however, further adaptation and coping strategies are required.

III. METHODOLOGY

The objective is to create a framework of adaptation measures and elements pertinent to use of waste landscapes, conceived from slums of developing countries. Case study approach is used to provide a lens for understanding the use of urban landscape as an element for gaining flood resilience. As a possible working basis for this ongoing reflection regarding potential types of adaptation measures applicable with urban landscape pertinent to slums, the strategies are considered from case examples and presented in a theoretical framework of parameters. Parameters being divided as 1. Resist 2. Delay 3. Storage and 4. Discharge (Table I). The framework's overall output is intended to be generic in nature and simple in form.

Table 1: Proposed Parameters of Flood Adaptation for Slums

Parameter	*Description*
A. Resist	*Measures that relate to the infrastructural strategy of 'resist' can be characterized by their ability to withstand the effect and impact of flooding. The measures can be flexible and temporary in nature with the ability to modify in accordance to changes in flood conditions. It is an essential attractive strategy to face the tidal flooding in coastal slums and along river basins.*
B. Delay	*Measures that relate to the infrastructural strategy of 'delay' comprises characteristics to postpone the impact and provide for ability to reduce the vulnerability of slum dwellers. Allowing them to prepare and tolerate the sudden flood conditions.*
C. Store	*Measures that entail the infrastructural capacity to 'store' water also provide for reducing the surface runoff. The storage measures or tanks can be over or below the ground surface. Can be open storage like a pond, an open step well or an underground closed storage infrastructure. Stored water can be cleaned and filtered. The measures can vary in scale and dimensions depending upon the incurred cost and requirements. Such elements and measures are particularly important for urban slums as they provide for water required for washing of cloths, bathing etc.*
D. Discharge	*Measures that comprises the characteristics of 'discharge' capabilities to infiltrate and convey or transfer back the stored water from flooding. The stored, filtered water through suitable filtration membrane such as gravel or rock with such measures can be reutilized and transferred through trenches or channels for other purposes. In slum neighborhoods, in particular, are significant to address the usual issues related with proper formal water supply.*

The conceptual framework of measures and elements derived from case examples are presented in the parameters discussed above. (Table II).

Table 2: Summary from Case Examples: Framework of Measures and Elements

Category	*Measures and Elements*	*Parameter*
Measures involving post-industrial landscapes	*Cleaning of waterways*	*C*
	Integration of waste waterways and channels	*C*
	Creating new and converting historical water elements into adaptive water reservoirs such as underground tanks, detention lawns, wetlands and retention pond.	*C, D*
	Dikes	*A*
	Integrating step-wells	*C, D*
	Integrating maidans or open grounds as absorbing element	*C*
	Dredging of rivers	*A, B*
	Retention walls	*A, B*
Local community driven	*Sandbag walls*	*A, B*
	Portable, attachable or foldable protection elements – plastic coverings of roofs and windows	*B*
	Raising of plinths	*B*
	Displacement to upper floors	*B*
Others	*Concrete tripods*	*A*
	Green roofs	*C, D*
	Permeable pavements	*C*
	Open drainage systems such as street channels and check dams	*D*

Green landscape infrastructure and public space here refers to all the spaces in the urban slums available for free access by all slum dwellers. Examples include playgrounds, park, open fields within community centers, religious buildings and school grounds, streets and squares, step-wells and river ghats. Apart from listed measures and elements in table II derived from case examples, there are more measures from which are not prominently used in urban slums but can be included as consideration.

IV. DISCUSSION AND RESULTS

In light of the constructed database of measures and elements in parameters as presented in the table, various frameworks can be proposed. The identified categories and types of measures can be differently organized in accordance with requirements and contexts. Table III is a sample illustrative diagram for the application of identified measures for slums.

The classification is in the light of the following questions: how slum dwellers can answer frequent floods? Is the waste landscapes in slums an essential tool for adaptation endeavors? Does retrofitting green public spaces with low cost community driven measures provide for flood resilience in urban slums.

Table 3: Illustrative Diagram of Toolkit Subject to Type of Flooding, Infrastructural Strategy, Result and other

Category	*Measure*	*Example*	*Type of flood*			
			1	*2*	*3*	*...**
Category 1	*Measure 1*	*e.g. 1*	*X*	-	-	...
		e.g. 2	-	*X*	*X*	...
		e.g. 3	*X*	-	*X*	...
	Measure 2	*e.g. 1*	-	*X*	-	...
		e.g. 2	-	*X*	*X*	...

*each example can further be analyzed on aspects like result, cost and local driven measures etc.
Results may be revisited and transformed with new examples and local community innovations in each situations.

A traditional landscape element represents a living heritage and elaborates a link between the past and present. It is a vital narrative of urban notion. Correa in his work 'the new landscape' addresses space as a resource, describes 'maidans' as an essential 'open-to-sky' spaces. His illustration on hierarchy of spaces in a neighborhood also exists in urban slums and plays as an essential element of use for community development and climate resilience. To address vulnerabilities to climate change and flooding in particular, focus must therefore, increase in carbon-sequestering landscapes such as urban forests, environment protective parks, green roofs, wetlands, and redesign the waste spaces and infrastructure for concrete cities to return to their natural porosity, increase public health and urban adaptability. It is critical to re-think the scale, design, and spatial distribution of public spaces. Through the examples it is clear that landscape as green infrastructure plays an essential role in flood adaptation for slums. An initial exercise was therefore here presented, in order to organize, comprehend and identify different types of measures. Through this maturing field of knowledge, a new lexicon of ideas, a flexible set of measures and elements will assist in providing the climate resilience for future slums.

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